KISII UNIVERSITY

UNIVERSITY EXAMINATIONS

FIRST YEAR EXAMATIONS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN EDUCATION

MATH 113: VECTORS AND MECHANICS TIME: 2 HOURS

INSTRUCTIONS

1. **Do not write on this question paper**
2. **Answer questions ONE and any other three questions**
3. **Show all the relevant workings**

QUESTION ONE (C0MPULSARY)

a) Given $\underset{\sim}{r}_1 = 5\underset{\sim}{i} + 3\underset{\sim}{j} + \underset{\sim}{k}$ and $\underset{\sim}{r}_2 = -3\underset{\sim}{i} + \underset{\sim}{J} + 2\underset{\sim}{k}$ obtain a unit vector that is parallel to the sum of $\underset{\sim}{r}_1$ and $\underset{\sim}{r}_2$ (4mks)

b) Given u=(0,3,-4) and v=(1,-1,4).
Find ; i) the Euclidean inner product of u and v (2mks)
ii) the angle determined by u and v

c) Find the area of the parallelogram with vertices P(1,-2,3), Q(4,3,-1),R(2,2,1) and S(5,7,-3) (7mks)

d) Show that the force field $F = 2x\underset{\sim}{\imath} + 6y\underset{\sim}{J}$ is conservative force. (4mks)

e) A particle of mass 2kg starts from rest at the origin of an inertial coordinate system at t=0. A force $F = 2\underset{\sim}{\imath} + 4t\underset{\sim}{J} - 6t^2\underset{\sim}{k}$ is applied to it.
Find the; i) acceleration and
ii) velocity of the particle at any given time. (6mks)

QUESTION TWO

a) A block of metal having a mass of 50kg requires a horizontal force of 50N to drag it with a uniform velocity along a horizontal surface. Calculate the coefficient of friction between the block and the surface (take gravity=10m/s^2 (3mks)

b) Find the force constant of a spring that is stretched to 25cm by a mass of 0.6kg (3mks)

c) Consider the vectors u=(o,0,1) and v=(1,0,4).
Find ;i) the orthogonal projection of u and v (5mks)
ii) the component of vectors u perpendicular to v (4mks)

QUESTION THREE

a) If $x_1a + y_1b + z_1c = x_2a + y_2b + z_2c$ where a,b,c are non-coplanar then show that ; $x_1 = x_2; y_1 = y_2$; $z_1 = z_2$ (7mks)

b) Given u=(2,-1,3) and v=(0,1,4) obtain a unit vector that is parallel to u$\times v$ (8mks)

QUESTION FOUR

a) Given a vector function F defined by $F = e^{4x}i + \sin(xy)\,j + xIn(xy)k$. obtain the DivF (7mks)

b) If an acceleration of a particle in as straight line with single harmonic motion is $\omega^2 x$ when the displacement from a central point is x. Prove that the velocity of the particle is given by $v^2 = \omega^2(a^2 - x^2)$ where a is the amplitude. (8mks)

QUESTION FIVE

a) If a vector function F is defined by $F = 2\text{xyi} + e^x \text{sin}zk$. Determine DivF (7mks)

b) If $= xzi - yj + 2\text{x}^2yk$. Find curlA (8mks)

QUESTION SIX

a) A mass M rests on a smooth horizontal plane and is attached by two inelastic strings to to masses m_1 and m_2, where $m_1 > m_2$ which hang over smooth pulleys at opposite edges of the table. Find the acceleration of the system and the tension in the strings. (10mks)

b) Find the work done in moving an object at a vector; $r = 3i + 2j - 5k$ if the applied force $F = 2i - j - k$ (5mks)

Marking scheme

a) A=2i+4j+3k

$\frac{2i+4j+3k}{\sqrt{29}}$

b) U.V=-19

Cosθ=$\frac{-19}{\sqrt{25}\sqrt{18}}$=0.895668

c) u = pq = (3, 5, -4)

v = pr = (1, 4, -2)

u x v = $\begin{vmatrix} i & j & k \\ 3 & 5 & -4 \\ 1 & 4 & -2 \end{vmatrix}$

= 6i + 2j + 7k

= √89 =

d) v kF = i j k

$^{2}/_{2}$x $^{2}/_{2}$y $^{2}/_{2}$y

2x 6y 0

= 0 - 0 + 0

= 0

e) a $\frac{= F}{M}$= ½(2i + 4tj + 6t^2 k)

= i + 2tj + 3t^2 k

a = (i + 2tj + 3t^2 k) dt

v = ti + t^2 j + t^3 k + c_1 , at v = 0, t = 0, c_1 = 0

v = ti + t^2 j + t^3 k.

Question Two

a) N = 0.5N

M = $\frac{50}{}$ = 100

0.5

b) k =

$$= \frac{0.6 \text{ x } 10}{0.25}$$

= 24 N/M

c) w_1 = 4 (1, 0, 4)

W_2 = (1,8/5,3/5)

W_2 = -4/5, 0, 3/5

Question Three

a) $(x_1 - x_2) a + (y_1 - y_2) b + (z_1 - z_2) c = 0$

$$a = \frac{(y1 - y2)\,b}{x1 - x2} - \frac{(z1 - z2)\,c}{x1 - x2}$$

$$\frac{y1 - y2}{x1 - x2} = 0, \qquad \frac{z1 - z2}{x1 - x2} = 0$$

$y_1 = y_2$, $z_1 = z_2$.

$$b = \frac{x1 - x2}{y1 - y2} = \frac{z1 - z2}{y1 - y2}$$

$x_1 - x_2 = 0$, $-(z_1 - z_2) = 0$

$x_1 = x_2$, $z_1 = z_2$

hence

$x_1 = x_2$, $y_1 = y_2$, $z_1 = z_2$

b) U ×v = -7 I – 8j + 2k.

$$u = \frac{1}{\sqrt{117}\quad(-7\text{i} - 8\text{j} + 2\text{k})}$$

Question four

a) (d/dx i + d/dy j +d/dt k) (e^4 i^7 + sw (xy) j +x/nyt_k)

$=4e^{4x} + x \cos(xy) + x/yt\ y$

b) $X_1 = a \cos wt$, $dx/dt = v$

$V^2 = a^2 w^2 \sin^{-2} wt$ -(3)

$X^2w^2 = w^2a^2\cos^2 wt$ _(4)

Add 3 to 4

$V^2 = w^2(a^2 - x^2)$

Question five

a) $(d/dx\ i + d/dyj + d/dt^k)(2xyi + e^k \sin tk)$

$2y + e^x \cos t.$

b)

$$\vec{\nabla} \times A = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ d/dx & d/dy & d/dt \\ Xz & y^2 & 2x^2y \end{vmatrix}$$

$=2x^2i - (4xy - x)\ J + (0)\ k$

$=2x^2i + (x - 4xy)\ J$

Question six

$$a = \frac{mg(\sin x - m\cos x) - m2g(\sin B + m\cos B)}{m1 + m2}$$

$T = 1/2\{ M1g\sin\theta - Mm1g\cos\theta - m1a + m2a + m2g\sin B + MM2g\cos\}$

b) W = $2i - J - K \quad 3i +$

$=9J$

KISII UNIVERSITY

KERICHO CAMPUS

FACULTY: (EDUCATION)

COURSE: (bachelor of education)

COURSE CODE: (MATH 113) COURSE TITLE: (vectors and mechanics 1)

YEAR: one SEMESTER: two SESSION: (august December 2017 semester)

NAME OF INSTRUCTOR: OGEGA A. PATRICK PHONE NO: (0710819906)

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COURSE CONTENT/ COURSE DESCRIPTION

Vectors.Motion in a straight line.Relative motion.Connected bodies.Friction. Moment and couples. Statistics of particles and rigid bodies. Centre of gravity and linear equations.

COURSE OBJECTIVES

By the end of the course students should be able to work out sums involving . Vectors.Motion in a straight line.Relative motion.Connected bodies.Friction. Moment and couples. Statistics of particles and rigid bodies. Centre of gravity and linear equations.

COURSE OUTLINE

WK	MAJOR TOPIC	SUB TOPICS	METHODOLOGY
1	Vectors.	Dot and cross product	
2	Motion in a straight line.		Illustration on the board, exercise
	Relative motion	Relative motion	"
3	.Connected bodies		"
4	.		"
5			"
6	Statistics of particles and rigid bodies.	Statistics of particles and rigid bodies.	"
CAT 1			"
7	Centre of gravity and		"
8			"
9	Friction	Frictional coeffient	"
10			"
CAT 2			

11	Moment and Couples	Moment and Couples	"
12		Moment and Couples	
13	COURSE EVALUATION (EXAMINATIONS)		

REFFERENCE

Clayton W. D. (1986) Euclidean Geometry and Transformations vol. 1 Cambridge University press. Pg 216-222

Gibert Strang (2000) Introduction to Linear Algebra, Fourth Edition, Wellesley-Cabridge press. Pg46-50 and pg 89-115.

Gibert Strang (2016) Introduction to Linear Algebra, Fifth Edition, Wellesley-Cabridge press. Pg78-84

William C. 1990) Introduction to complex Analysis Lecture notes Vol. 2 Pg 6-11

Arapua and Dona (2009) Algebraic Geometry Over Complex Numbers,